Temperature and humidity interact to influence brown marmorated stink bug survival

Joanna J. Fisher¹, Jhalendra Rijal², Frank Zalom¹

1. Department of Entomology and Nematology, UC Davis

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BMSB in CA: Different landscape (less bordering forest and urban areas)

Central Valley California

Northeast
So far CA BMSB populations are lower than Northeast
Due to high temperatures? Low humidity?

Central Valley California

Northeast
Brown marmorated stink bug

Tree in Sacramento CA 2015

Photo: Chuck Ingles
Unusual number of hot temp days in Jul + Aug 2016 (above 35°C and below 16% RH)

Ingles and Daane, 2018 J. Econ. Entomol.
Unusual number of hot temp days in Jul + Aug 2016 (above 35°C and below 16% RH) followed by near zero trap counts.

Ingles and Daane, 2018 J. Econ. Entomol.
Questions

• Do high temperatures kill BMSB?
• What about low humidity?
• How will temperature and low humidity impact different BMSB life stages?
Goal: Determine effect of field temperature and humidity on BMSB survival
Placed egg masses in different CA sites and adults in almond trees in Stanislaus

Community Garden
Sacramento County

Almond Trees
Stanislaus County

Cherry Orchard
Solano County

Tree of Heaven
Yolo County
• Adults left in field for 1 week, Eggs for 2 days
• Recorded survival after exposure to summer temperatures
Temperature and Humidity at 4 sites Jul-Sept 2017

Strong linear relationship between temp and humidity in the field so can’t determine individual effect of temp vs. humidity.
Temperature and humidity (are highly correlated) influenced hatch rate. High temp (low RH) decreases hatch rate.
High temperatures and low humidity decreased adult survival.
What we learned from the field study

Temperature and humidity are highly correlated

Observed BMSB population declines in the field are at least partly the result of high temperature and low humidity events
Is Temperature or Humidity more Important for Predicting BMSB Mortality?
Back to the lab! Experiment Set-up

Saturated salt solution maintains a specific relative humidity

Insects
Insect life stages:
- Eggs
- 1st instars
- 3rd-4th instars
- Adults

Avg. Humidity:
- 17%
- 39%
- 56%
- 79%

2 day high temp exposure:
- Ambient: 27°C const
- High temp: 39°C 3.75hr.
- Very high temp: 42°C 3.75hr.
• No effect of humidity on BMSB survival at low temperatures
At 40°C exposure to 17% humidity decreased BMSB survival.
At 42°C BMSB have slightly higher survival if exposed to 39% humidity
High temperature exposure significantly decreased BMSB survival of all BMSB lifestages.
High temperatures reduced the number of eggs that developed to the 1\textsuperscript{st} instar and the number of 1\textsuperscript{st} instars that developed into 3\textsuperscript{rd} instars.
Fewer eggs were laid upon adult exposure to 42°C

![Graph showing mean egg masses per female at different temperatures. The graph indicates that 42°C results in significantly lower egg masses compared to 27°C and 40°C.](image-url)
• Humidity does not matter for egg hatch
1st instar nymphs die when exposed to low humidity.
• High humidity slightly decreases 3\textsuperscript{rd} - 4\textsuperscript{th} instar survival

![Diagram showing percent survival for stink bug life stages: egg, first instar, and third instar. The graph indicates that high humidity slightly decreases the survival of 3\textsuperscript{rd} and 4\textsuperscript{th} instars compared to the egg stage.](Stopbmsb.org)

- Egg survival: 17%
- First instar survival: 39%
- Third instar survival: 56%
- Adult survival: 79%

### Percent Survival %

<table>
<thead>
<tr>
<th>Stink bug life stage</th>
<th>Egg</th>
<th>First</th>
<th>Third</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent Survival %</td>
<td>17%</td>
<td>39%</td>
<td>56%</td>
</tr>
</tbody>
</table>

**Note:** The diagram illustrates the survival percentages for stink bug life stages under high humidity conditions. The survival of the 3\textsuperscript{rd} and 4\textsuperscript{th} instars is slightly decreased compared to the egg stage.
• Humidity does not matter for adult survival
The impact of humidity on BMSB survival depends on the insect life stage.

The figure shows the percent survival of BMSB at different life stages: egg, first, third, and adult, under various humidity conditions. The survival rates are marked with different letters, indicating significant differences in survival across the stages and humidity levels.
- Humidity did not influence the number of eggs that developed to the 1\textsuperscript{st} instar.
- Low humidity reduced the number of 1\textsuperscript{st} instars that developed to the 3\textsuperscript{rd} instars.
Fewer eggs were laid upon adult exposure to 79% rh
Is Temperature or Humidity more Important for Predicting BMSB Mortality?
Both matter!

High temperatures decreases the survival of all BMSB life stages

Humidity had no effect on adults or eggs but low humidity killed 1\textsuperscript{st} instars,
High humidity reduced older nymph survival

Overall findings:
High temperature and low humidity seem to be factors in the observed decline of BMSB populations in CA following high temperature events
Why it matters

• Could see lower populations in hot and dry areas/hot and dry years.

• This data can be used to help predict the ability of BMSB to spread into new areas and how climate and high temperature events will impact BMSB population levels.
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